

CHAPTER 3 ARCHITECTURAL DESIGN

3-1. General Architectural Considerations.

a. Locale. Locale will determine some basic design factor: that must be considered in the layout and architectural design of the facility. Geographical impacts may include prevailing weather effects on the building mass design. For example, periodic freezing precipitation requires recessed or covered exterior entrance/egress doors and solar shielding may be appropriate in arid or warm regions. Stringent seismic design requirements impact on some architectural details, particularly when masonry is used for structural or aesthetic purposes. Location can also impact on the basic design because of aesthetic requirements. In a remote site, the structure could require only a utilitarian envelope while a more urban location would require more attention to architectural appearance.

b. Native Architecture. The architecture of the community or region should be considered in selecting the architectural style. If there is an existing prevailing style that would be derogated by a contrasting structure, a similar or complementing style using materials and characteristics of the existing architecture should be strongly considered.

c. Materials. Criteria for material selection, in descending order of importance, should be performance, durability, maintainability, economy, and aesthetics. Materials and systems to be used for construction should conform to standard Federal or Corps specification requirements and recognized standards such as those of the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI). Specifications should require materials that are readily available and likely to be available in the future so as to minimize maintenance and repair costs throughout the design life of the structure. Native materials should be used where feasible.

d. Functional Design. The spatial plan and volumes derived in the pumping station design should provide an organization of the necessary spaces in a fundamental relationship that satisfies the following:

- (1) Spaces for all equipment and personnel.
- (2) A proper relationship of functions for efficiency, economy, and an organized overall building mass.

(3) A structure and envelope which meets the requirements of the current building code applicable to the geographic location unless directed otherwise by local authority to comply with more restrictive local codes.

(4) Efficient interior and exterior traffic patterns for people, cranes, mobile equipment, and maintenance operations.

(5) Adequate egress space and components to meet the current NFPA 101 Life Safety Code and NFPA 80, Fire Doors and Windows.

(6) Adequate building facilities and provisions to meet national safety and health codes, especially OSHA.

(7) Verification that the pumping station will be manned by an able-bodied staff or if the station will require extra measures in space and equipment to meet the handicapped codes.

(8) Public access should be arranged such that unescorted tours of the station are possible without interference with normal operation.

e. Space Requirements. Specific space requirements will be determined by the equipment required to perform the pumping functions of the station and all of the other equipment and support activities associated with its operation. In all but the smallest stations, the following spaces are usually required:

(1) Adequate spaces for basic pumping equipment installation, maintenance, and removal.

(2) Supporting personnel areas including space for direct access into the station, an office enclosure for administrative operations, and a toilet.

(3) Storage areas for operational portable equipment, general supplies, and tools when required for on-site maintenance activity.

(4) Functionally related exterior and interior spaces for the access, handling, and exiting of large equipment during its replacement or maintenance.

(5) Egress space as required by NFPA Life Safety Codes for exit access and discharge.

f. Vandalism. Exterior building components should be selected, located, and installed in such a manner as to deter pilfering or physical damage to the station by vandals.

3-2. Safety. The physical components of the building including the general envelope, structural system, walls, partitions, corridors, stairs, and doors related to personnel egress patterns or hazardous storage must comply with the requirements of NFPA 101 Life Safety Code and NFPA 80 Fire Doors and Windows. Equipment areas, equipment access areas, and access components therein, such as ladders, platforms, and guard rails, must comply with the requirements of OSHA, including those regarding noise.

a. Barriers. Security fences should be used as a deterrent but should not be hazardous. Exterior railings should comply with OSHA except that those in public access areas intended to prevent falls to levels more than thirty inches below should be in compliance with NFPA 101 Life Safety Code. Interior railings used in personnel egress patterns should also comply with NFPA 101 Life Safety Code.

b. Gratings. Gratings in floors of equipment areas must comply with OSHA Standards. Gratings and other perforated surfaces are not allowed in personnel egress route floors.

c. Signage. As a minimum, signage must be provided for piping identification by standard codes, personnel egress routes, and all hazards.

3-3. Types of Construction. In general, a pumping station should be a permanent, low-maintenance, and secure structure. Pumping stations should be constructed of fire-resistant or noncombustible materials such as reinforced concrete, masonry, structural steel, or combinations. Generally, a monolithic reinforced concrete structural frame or a structural steel frame with a concrete or masonry skin will provide the desired qualities producing long-term service and low maintenance. Steel structures with metal skins generally afford a lower first cost. However, they are also more susceptible to maintenance problems, have shorter life spans, and have inherent acoustical problems when enclosing noisy equipment.

3-4 Architectural Designs. Some of the important architectural designs are discussed in the following paragraphs.

a. Structural Systems. The interfacing of dissimilar materials at the juncture of structural frame components and envelope systems requires special attention. Arrangements where

the envelope system is connected to an exposed structural frame are not recommended because of weather tightness problems at the junction. A crane support system should be independent of the building envelope unless it is economically feasible for both systems to be monolithic concrete. Where the structural system for a crane is integral with the envelope system, the juncture requires special attention because of the transfer of superimposed loads.

b. Beams, Columns and Pilasters. The location and depth of beams should be coordinated with the layout of equipment to be installed and with the vertical clearances within the spaces to prevent conflicts with equipment, ducts, pipes, fittings, supports, operational headroom, and maintenance operations. If load-bearing walls or concentrated loadings cannot be supported by structural walls or columns, beams or adequate floor design must be provided. Smooth-surface reinforced concrete is usually preferred for girders and beams because of low maintenance costs. Steel or composite construction may require additional maintenance because of the nature of the materials. Columns and pilasters should be simple in form except where dictated otherwise by aesthetic considerations. Concrete should be used as the column material when feasible; steel is acceptable when reduced first cost is a factor, but masonry columns should be avoided.

c. Walls. Exterior walls, in addition to being structurally sound, must be durable, contain as few openings as practical, require little maintenance, and contribute aesthetically. Concrete or masonry which does not require painting is preferred. Walls below grade which enclose operating areas should be of reinforced concrete. Where functions of areas below grade require dry conditions, or where the water table is known to present hydrostatic problems likely to circumvent normal waterstops, a permanent enclosure such as a three-ply waterproof membrane is required. Retrofit or superficial measures such as sump pumps, which present long-term additional maintenance problems should be avoided, if possible.

d. Floors. Floors should be constructed of concrete with a wood float finish in most areas of pumping stations. Steel trowel finished concrete or other superficial floor finishes may be used in certain specified areas. Floor opening covers should be checkered steel plate, set flush in steel angle frames with gas-tight resilient seals. Steel grating may be used in outdoor locations. A cover juncture of the floor and wall surfaces is desirable as an aid to efficient cleaning. The cover should be

of permanent hard material so as to withstand wash down operations. Where floors slope to drains, the entire floor area should slope, not just the area adjacent to the drain.

3-5. Roofing. Roof systems should be appropriate for the locale. Roofing may be built-up, shingles, metal, or tile. Tile or slate shingles provide long term service but usually have a higher initial cost. The other systems have a lower initial cost but require more maintenance and have shorter life expectancies. Single-ply roofs with ballast can catch dust, dirt, leaves, and seed, and consequently grow vegetation requiring more maintenance. Ballastless single-ply roofs are subject to uplift and problems caused by direct ultraviolet exposure. Built-up roof systems using wood-fiber-based felts should be avoided. Fiber-glass-based felts perform well, as do rag-based felts. Galvanized metal, composition shingles, built-up systems, and single-ply roofs can be expected to perform adequately for approximately fifteen years. Thus, any economic evaluation of these types of roofing against other more durable systems must provide for initial installation plus several roof replacements during the design life of the facility. If economically feasible, the optimum fifty-year design roofing of tile, slate shingles, copper or other noncorrosive metal should be used. Additionally, if the station location is such that aesthetics is an overriding factor, appearance considerations may justify an additional expense consistent with good architectural design.

a. Parapets. If parapets are used on all sides of the building, care must be taken to provide secondary overflow scuppers or other drains to insure positive roof drainage should the primary drainage system become clogged.

b. Slope. Limitations on slopes of different roofing systems vary. The slope of built-up roofs should not be less than one-quarter inch per horizontal foot. Generally, the slope of built-up roof should be between one-quarter and one-half inch per horizontal foot. Slopes of the built-up roof greater than one-half inch per horizontal foot require mechanical fastening of the system, and type II asphalt is required on slopes up to one inch per horizontal foot and type III is required on steeper slopes. Built-up roof slopes exceeding one inch per horizontal foot should be avoided. The minimum slope for composition shingle roofs is two inches per horizontal foot. The minimum slope for slate shingles is three inches per horizontal foot. Shingles sloped less than four inches per horizontal foot require two layers of felt underlayment, while those sloped more than four inches require only one. Metal roofs do not generally

perform well at slopes less than three inches per horizontal foot. Slopes for various types of tile roofs are generally steeper than for other systems, the minimums being three inches per foot for flat tile, four inches for Spanish "S" tile, and five inches for barrel "pan and cover" tile.

c. Expansion Joints. Roofing expansion joints should only be used along lines of expected differential movement between separate segments of the building or when the roof system is so large that thermal control will be a problem. The latter is unusual for pumping stations as they are relatively small structures. When joints are required, a durable expansion joint material should be selected to provide long, trouble-free service.

d. Flashing. Particular detailing emphasis should be placed on the perimeter of the roof. Curbs, penetrations, parapets, scuppers, and gutters present far more leakage problems than the roof membrane itself. Roof details such as perimeter parapets or wall-to-roof junctures should be designed to allow adequate movement without rupture by the proper use of flashing, counter-flashing, and materials which will provide long-term service.

Penetrations. The mounting of equipment, antennae, flag poles, guy-wires, or other such items on or through the roof system should be avoided if possible, as such point-loadings and penetrations often become sources of leakage problems. Where penetrations are necessary, pitch pockets should be avoided since they are sources of repetitive leakage problems.

f. Roof Drainage. Gutters, with or without downspouts, should be avoided because of year-round maintenance problems, especially in the winter. Roof drainage discharge should be designed so that it does not interfere with building access and egress, is not detrimental to exterior equipment, and does not create standing water or long-term wet conditions at ground level.

g. Roof Insulation. Roof insulation, when required, should be appropriate for the roofing system and the roof structure.

3-6. Windows and Skylights. Careful consideration should be given to the need for windows or skylights. Openings in the exterior walls should be restricted to the minimum required for efficient operation of the station because they require maintenance and are subject to vandalism. Windows are not usually

warranted for the use of daylight for energy conservation purposes and visibility to the outside of a pumping station is not of primary importance. Any required fenestration should be in character with the architectural style of the station. Window hardware should be sturdy and durable and of noncorroding material. Frames and sashes should be of metal rather than wood. Perimeter closure material should be a nonhardening flexible paintable "sealant" rather than "caulking." Head and sill flashings should be of durable noncorrodible materials such as a flexible elastomeric synthetic or copper. Lintels or corresponding components in composite wall construction must be structurally adequate, properly flashed, and shaped to withstand the elements. Skylights should be of one-piece construction, self-flashing, and of the curb-mounted type.

3-7. Doors. All doors should be selected for function, good security, durability, and heavy industrial usage. Doors of hot-dipped galvanized steel, flush or paneled design as aesthetically required, are more durable than primed steel, aluminum, or wood. Metal gauges should be adequate to withstand abuse from impacts caused by the handling of heavy equipment.

a. Ratings. Door and frame construction required to carry fire labels must be in compliance with the NFPA 101 Life Safety Code and NFPA 80, Fire Doors and Windows.

b. Hardware. Butts, locksets, latchsets, closers, holders, and kick plates should all be selected for long-term service. Locksets with removable cores for easy keying changes should be specified. Butts should be heavy and noncorrodible. Exterior out-swinging doors should have butts with nonremovable pins. Padlocks should be avoided as they can be easily cut.

3-8. Stairways. Stairs should be constructed of concrete, steel, or a combination of the two. Wood construction should not be used. Treads should be provided with nonskid nosings or an integral abrasive in the tread surface. Stairways that are part of the egress pattern must have widths, run lengths, landings, treads, risers, handrails, guardrails, headroom, door sizes, door swings, door ratings, interior finishes, windows, and other openings in accordance with NFPA 101 Life Safety Code and NFPA 80 Fire Doors and Windows. Stairs and ladders for equipment access need only comply with OSHA requirements.

3-9. Toilet Facilities. A toilet with a lavatory and water closet should be provided unless satisfactory facilities are available adjacent to or not too distant from the station. Electronic toilets which need not be drained in freezing weather

should be used in locations that experience extremely cold winters. Toilet areas require absorption-resistant surfaces to afford easy long-term maintenance.

3-10. Sheet and Miscellaneous Metal. All sheet and miscellaneous metal should conform to applicable Federal Specifications, but should generally be of noncorroding material.

3-11. Interior Finishes. Elaborate or ornate interior finishes should not be used. Durable but easily maintained finishes should be used.

a. Floors. Floors should typically be exposed concrete, broom or steel trowel finished as required by the use of the area.

b. Interior Walls and Partitions. Interior walls and partitions should be smooth, durable, easily cleaned, and painted only where light reflectivity or sealing of the surfaces are required. In general, exposed concrete does not need additional finish material unless climatic conditions dictate additional envelope U-Value requirements.

c. Ceilings. Except for office areas which should have an acoustical ceiling system and toilet areas below a high roof structural system, no special ceiling installation is required.

d. Office Areas. Office areas should be simple but comfortable, easily cleaned, and enveloped in a space of low sound transference with surfaces of good light reflectivity and low sound reverberation.

e. Ferrous Metals. Where frequent moisture or contact with human hands is expected, such as at stair handrails and guardrails, ferrous metals should be hot-dip galvanized. Other ferrous metal items such as columns, beams and other exposed structural building components should be primed and painted.

3-12. Built-In Furniture. Built-in furniture should not be used except as required for special applications where movable furniture does not meet the needs of the function.

3-13. Screening. Exterior openings such as louvers or ventilators should have screening to prevent the entry of birds, rodents, and insects. Such screening should be located other than on the outside face of the opening so as to inhibit vandalism, while remaining accessible for screen replacement when required.